Notice of Allowability	Application No. 09/804,830	Applicant(s) CHOU, CHIEN	
	Examiner Jason M. Perilla	Art Unit 2638	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the amendment filed April 28, 2005*.

2. ☒ The allowed claim(s) is/are *claims 1-3, 5-12, 14-19, 21-24, and 26-28 renumbered respectively as claims 1-24*.

3. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date *20050914* .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

EXAMINER'S AMENDMENT

1. Claims 1-3, 5-12, 14-19, 21-24, and 26-28 are pending in the instant application.

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with William Park (55523) on September 14, 2005.

The application has been amended as follows wherein claims 2, 8, 12, and 24 are cancelled and the following versions of claims 1, 3, 7, 9, 10, 17, 21, 22, and 26 replace all prior versions in their entirety:

1. A phase demodulator for measuring a phase difference between a phase-modulated test signal $I_s(\omega t)=2k_1\cos(\omega t+\psi_s)$ and a phase-modulated reference signal $I_r(\omega t)=2k_2\cos(\omega t+\psi_r)$, the test and reference signals having fixed carrier frequencies (ω), ~~the~~ <u>a</u> phase difference ($\Delta\psi$) being equal to (ψ_s-ψ_r), said phase demodulator comprising:

an amplitude control device for adjusting amplitudes of the test and reference signals to satisfy the condition $k_1=k_2=k$;

a differential amplifier, coupled to said amplitude control device, for receiving the amplitude-adjusted test and reference signals from said amplitude control device, for obtaining an intensity difference between the amplitude-adjusted test and reference signals, and for amplifying the intensity difference to generate an amplitude-modulated output $I_{out}(\omega t)$ equal to $|4\gamma k\sin(\frac{1}{2}\Delta\psi)|\sin(\omega t)$, where γ is the gain of said differential amplifier; and

a signal processing device ~~including~~ <u>comprising:</u>

an amplitude demodulator coupled to said differential amplifier, said amplitude demodulator demodulating the amplitude-modulated output from said differential amplifier to obtain an output that is related to the phase difference (Δψ); and

a phase comparator, coupled to said amplitude control device, for determining a sign of the phase difference (Δψ) from the amplitude-adjusted test and reference signals and for determining an increasing or decreasing direction of change in the phase difference (Δψ).

2. (cancelled) ~~The phase demodulator of Claim 1, wherein said signal processing device further includes a phase comparator, coupled to said amplitude control device, for determining a sign of the phase difference (Δψ) from the amplitude-adjusted test and reference signals, and for determining an increasing or decreasing direction of change in the phase difference (Δψ)~~.

3. The phase demodulator of Claim ~~2~~ 1, wherein said amplitude control device includes a pair of automatic gain control units that receive the test and reference signals, respectively.

7. A phase difference detector adapted for use with a polarized optical interferometer that generates two mutually orthogonal polarized optical signals, at least one of which is incident upon a test object, the optical signals having equal intensities and carrier frequencies and being processed to obtain two electrical signals that are a function of a frequency, a time, and a phase difference between the two mutually orthogonal polarized optical signals, said phase difference detector comprising:

a differential amplifier adapted to receive the electrical signals, to obtain an intensity difference between the electrical signals, and to amplify the intensity difference to generate an amplitude-modulated output that is a function of a phase difference between the electrical signals; and

a signal processing device ~~including~~ comprising:

an amplitude demodulator coupled to said differential amplifier, said amplitude demodulator demodulating the amplitude- modulated output from said differential amplifier to obtain an output that is related to the phase difference; and

a counter such that when the phase difference between the electrical signals exceeds 2π, the phase difference as detected by said signal processing device includes a product of 2π and an integer recorded by said counter.

8. (cancelled) ~~The phase difference detector of Claim 7, wherein said signal processing device further includes a counter such that when the phase difference between the electrical signals exceeds 2π, the phase difference as detected by said signal processing device includes a product of 2π and an integer recorded by said counter.~~

9. An interferometric system, comprising:

a coherent light source;

an interferometer for separating light from said coherent light source into a signal beam and a reference beam, each of which includes two mutually orthogonal linear polarized components, the signal and reference beams having a beat frequency therebetween, at least one of the components of the signal beam being incident upon a test object, the signal and reference beams being combined and then separated into two mutually orthogonal linear polarized optical heterodyned signals that have equal intensities and equal carrier frequencies and that are a function of a beat frequency, a time, and a phase difference between each of the mutually orthogonal linear polarized components;

a photo detecting means for converting the two mutually orthogonal linear polarized optical heterodyned signals into two electrical signals;

a differential amplifier coupled to said photo detecting means so as to receive the electrical signals therefrom, said differential amplifier obtaining an intensity difference between the electrical signals, and amplifying the intensity difference to generate an amplitude-modulated output that is a function of a

phase difference between the <u>two mutually orthogonal linear polarized</u> optical heterodyned signals; and

a signal processing device ~~including~~ <u>comprising:</u>

an amplitude demodulator coupled to said differential amplifier, said amplitude demodulator demodulating the amplitude-modulated output from said differential amplifier to obtain an output that is related to the phase difference; <u>and</u>

<u>a phase comparator, coupled to said photo detecting means, for determining a sign of the phase difference ($\Delta\psi$) and for determining a direction of change in the position of the test object</u>.

10. The interferometric system of Claim 9, wherein:

said coherent light source is a single-frequency stabilized laser;

said interferometer including a polarization angle adjusting device for adjusting an azimuth angle of the light from said coherent light source, said polarization angle adjusting device being adjustable such that the intensities of the signal and reference beams satisfy the condition $\sqrt{I_{P1}I_{P2}}=\sqrt{I_{S1}I_{S2}}=K$, where I_{P1} and I_{S1} are the intensities of the mutually orthogonal linear polarized P_1 and S_1 components of the signal beam, I_{P2} and I_{S2} are the intensities of <u>the</u> mutually orthogonal linear polarized P_2 and S_2 components of the reference beam, said interferometer further including a beam splitter for splitting the light from said polarization angle adjusting device into the signal and reference beams, and first and second frequency modulators for modulating the signal and reference beams at different modulating frequencies, respectively, thereby generating the beat frequency ($\Delta\omega$);

one of the <u>mutually orthogonal linear polarized</u> optical heterodyned signals being $I_{P1+P2}(\Delta\omega t)$ that includes the P_1 and P_2 components and that is equal to $2K\cos(\Delta\omega t+\Delta\psi_P)$, where $\Delta\psi_P$ is the phase difference between the P_1 and P_2 components, the other one of the <u>mutually orthogonal linear polarized</u> optical heterodyned signals being $I_{S1+S2}(\Delta\omega t)$ that includes the S_1 and S_2 components and that is equal to $2K\cos(\Delta\omega t+\Delta\psi_S)$, where $\Delta\psi_S$ is the phase difference between the S_1 and S_2 components;

the magnitude of the amplitude-modulated output being $|4\gamma K\sin(½\Delta\psi)|$, where γ is the gain of said differential amplifier, and $\Delta\psi=\Delta\psi_P-\Delta\psi_S$.

12. (cancelled) ~~The interferometric system of Claim 10, wherein said signal processing device further includes a phase comparator, coupled to said photo detecting means, for determining a sign of the phase difference ($\Delta\psi$), and for determining a direction of change in the position of the test object.~~

17. The interferometric system of Claim 9, wherein:

said coherent light source is a single-frequency stabilized linear polarized laser;

said interferometer including a polarization angle adjusting device for adjusting an azimuth angle of the light from said <u>coherent</u> light source, said polarization angle adjusting device being adjustable such that the intensities of the signal and reference beams satisfy the condition $\sqrt{I_{P1}I_{P2}}=\sqrt{I_{S1}I_{S2}}=\rho$, where I_{P1} and I_{S1} are the intensities of the mutually orthogonal linear polarized P_1 and S_1 components of the signal beam, I_{P2} and I_{S2} are the intensities of the mutually orthogonal linear polarized P_2 and S_2 components of the reference beam, said interferometer further including a position-movable mirror that moves at a predetermined speed for introducing a Doppler frequency shift to the frequency of at least one of the signal and reference beams, thereby resulting in the beat frequency between the signal and reference beams;

one of the <u>mutually orthogonal linear polarized</u> optical heterodyned signals being $I_{P1+P2}(\Delta\omega t)$ that includes the P_1 and P_2 components and that is equal to $2\rho\cos(\Delta\omega t+\Delta\psi_P)$, where $\Delta\psi_P$ is the phase difference between the P_1 and P_2 components, the other one of the <u>mutually orthogonal linear polarized</u> optical heterodyned signals being $I_{S1+S2}(\Delta\omega t)$ that includes the S_1 and S_2 components and that is equal to $2\rho\cos(\Delta\omega t+\Delta\psi_S)$, where $\Delta\psi_S$ is the phase difference between the S_1 and S_2 components;

the magnitude of the amplitude-modulated output of said differential amplifier being $|4\gamma\rho\sin(½\Delta\psi)|$, where γ is the gain of said differential amplifier, and $\Delta\psi=\Delta\psi_P-\Delta\psi_S$.

21. An interferometric system, comprising:

a coherent light source;

an interferometer for separating light from said coherent light source into a signal beam and a reference beam, each of which includes two mutually orthogonal linear polarized components, the two mutually orthogonal linear polarized components of the signal and reference beams having a beat frequency therebetween, at least one of the components of the signal beam being incident upon a test object, the signal and reference beams being converted into two optical heterodyned signals that have equal intensities and carrier frequencies and that are a function of a beat frequency, a time, and a phase difference between the mutually orthogonal linear polarized components;

a photo detecting means for converting the optical heterodyned signals into two electrical signals;

a differential amplifier coupled to said photo detecting means so as to receive the electrical signals therefrom, said differential amplifier obtaining an intensity difference between the electrical signals, and amplifying the intensity difference to generate an amplitude-modulated output that is a function of a phase difference between the optical heterodyned signals; and

a signal processing device ~~including~~ comprising:

an amplitude demodulator coupled to said differential amplifier, said amplitude demodulator demodulating the amplitude-modulated output from said differential amplifier to obtain an output that is related to the phase difference; and

a phase comparator, coupled to said photo detecting means, for determining a sign of the phase difference ($\Delta\psi$) and for determining a direction of change in the position of the test object.

22. The interferometric system of Claim 21, wherein:

said coherent light source is a two-frequency laser;

said interferometer including a beam splitter for splitting the light from said coherent light source into the signal and reference beams, the reference beam

including mutually orthogonal linear polarized P_2 and S_2 components having the beat frequency therebetween, the signal beam including mutually orthogonal linear polarized P_1 and S_1 components having the beat frequency therebetween, at least one of the P_1 and S_1 components being incident upon the test object;

said interferometer further including first and second polarization analyzers, each of which receives a respective one of the signal and reference beams, and causes the respective mutually orthogonal linear polarized components of the ~~respective one of the~~ signal and reference beams to interfere with each other along a polarization direction thereof, each of said first and second polarization analyzers having an azimuth angle that is adjustable such that the intensities of the mutually orthogonal linear polarized components of the signal and reference beams satisfy the condition $\sqrt{I_{P1}I_{S1}}\sin 2\theta_s=\sqrt{I_{P2}I_{S2}}\sin 2\theta_r=2\chi$, where I_{P1} and I_{S1} are the intensities of the P_1 and S_1 mutually orthogonal linear polarized components of the signal beam, I_{P2} and I_{S2} are the intensities of P_2 and S_2 mutually orthogonal linear polarized components of the reference beam, θ_s is the azimuth angle of said first polarization analyzer for the signal beam, θ_r is the azimuth angle of said second polarization analyzer for the reference beam;

a one of the two optical heterodyned signals $I_{sig}(\Delta\omega t)$ for the signal beam being equal to $2\chi\cos(\Delta\omega t+\Delta\psi_{sig})$, another one of the two optical heterodyned signals $I_{ref}(\Delta\omega t)$ for the reference beam being equal to $2\chi\cos(\Delta\omega t+\Delta\psi_{ref})$, where $\Delta\omega$ is the beat frequency, $\Delta\psi_{sig}$ is ~~the~~ a phase difference between the P_1 and S_1 mutually orthogonal linear polarized components of the signal beam, and $\Delta\psi_{ref}$ is ~~the~~ a phase difference between the P_2 and S_2 mutually orthogonal linear polarized components of the reference beam;

the magnitude of the amplitude-modulated output of said differential amplifier being $|4\gamma\chi\sin(\frac{1}{2}\Delta\psi)|$, where γ is the gain of said differential amplifier, and $\Delta\psi=\Delta\psi_{ref}-\Delta\psi_{sig}$.

24 (cancelled) ~~The interferometric system of Claim 22, wherein said signal processing device further includes a phase comparator, coupled to said photo detecting means, for determining a sign of the phase difference ($\Delta\psi$), and for determining a direction of change in the position of the test object.~~

26 The interferometric system of Claim 22, wherein said interferometer further includes a polarized beam splitter for splitting the signal beam into the P_1 and S_1 mutually orthogonal linear polarized components, the test object being a ring-type optical path unit, said polarized beam splitter feeding the P_1 and S_1 mutually orthogonal linear polarized components to the test object in opposite directions, and recombining the P_1 and S_1 components from the test object.

Claims 1-3, 5-12, 14-19, 21-24, and 26-28 are renumbered respectively as claims 1-24, and the claim dependency is renumbered accordingly.

Allowable Subject Matter

3. The following is an examiner's statement of reasons for allowance:

Claims 1-3, 5-12, 14-19, 21-24, and 26-28 renumbered respectively as claims 1-24 are allowed because the prior art of record does not disclose or obviate all of the claimed features. Specifically, the prior art of record (including Tsuji et al – US 5861952) do not disclose the claimed interferometric system *having a phase comparator* determining a sign of the phase difference from the amplitude-adjusted test and reference signals.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The following prior art of record is cited to further show the state of the art with respect to interferometric systems.

U.S. Pat. No. 5861952 to Tsuji et al.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason M. Perilla whose telephone number is (571) 272-3055. The examiner can normally be reached on M-F 8-5 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Vanderpuye can be reached on (571) 272-3078. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jason M. Perilla
September 14, 2005

jmp

CHIEH M. FAN
PRIMARY EXAMINER